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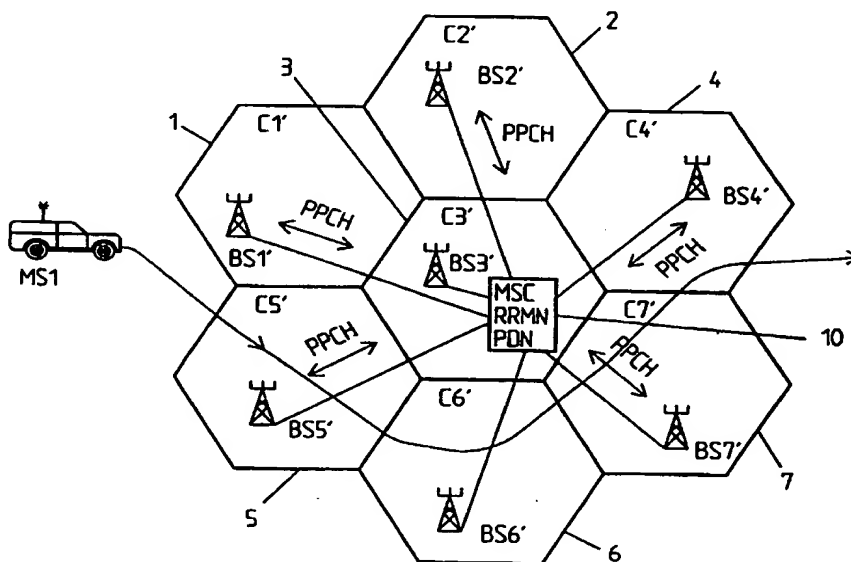
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## (57) Abstract

The present invention relates to a cellular radio communication system comprising a number of base stations (BS1', ..., BS7'), each of which serves a cell (C1', ..., C7'), and a number of switching arrangements each serving a number of base stations, and a number of mobile stations (MS1). Traffic channels are provided for communication of speech and/or circuit switched data and control channels are provided for communication of signalling information and/or synchronisation information. The system supports communication of packet data. A number of resource management nodes (10) are provided for managing channel resources and a number of packet data handling nodes are provided for handling packet data services. At least in some of the cells resources can be allocated on demand for communication of packet data in the respective cells. The invention also relates to a method of allocating channel resources in cellular radio communication system supporting packet data communication.

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Title:

ON-DEMAND CHANNEL ALLOCATION FOR PACKET DATA

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TECHNICAL FIELD

The present invention relates to allocation of channel resources in a radio communication system supporting transmission of packet data. The invention also relates to a method of communicating packet data in a cellular radio communications network.

STATE OF THE ART

In cellular radio communication systems, which are divided into a number of cells, each of which cells being served by a base station, and wherein a number of base stations groupwise are served or controlled by a switching arrangement, generally known as a mobile switching center, each cell generally contains a broadcasting channel (BCCH) for broadcasting of channel structure information on all the channels belonging to the cell. With channel structure information is here meant which kinds of channels exist, for what the channels are used etc.

In a cellular radio communication system supporting a so called packet data service (PDS), which means communication of packet data, the information broadcasted on the broadcast channel must contain information about the existence of, and possibly also the number of, packet data communication channels in the respective cells. The packet data communication channels are here also referred to as packet physical channels (PPCH). The usage of the packet data service however varies strongly throughout the

network, i.e. the cellular radio communication system. There are for example cells in which the packet data service is used to a high extent as well as there are other cells in which the packet data service is used very sparsely.

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In most cellular radio communication systems supporting communication of packet data, each cell contains at least one packet data communication channel, i.e. a channel which is reserved for communication of packet data only. It is apparent, 10 that in those cells in which communication of packet data only occurs to a very low degree, or very irregularly, it is unsatisfactory from the frequency planning point of view to always have at least one channel allocated for packet data communication purposes, i.e. to have one or more channels which only are used to 15 a very limited extent or only occasionally in order to still provide a satisfactory grade of service for the packet data service. It is of course also disadvantageous from an economical point of view that the available channel resources in a cell or in a system in general are not used efficiently.

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Thus, in a cellular system supporting communication of packet data the cells have to be equipped with packet data communication channels in order to meet the requirements as to the grade of service as specified by the operator of the network. The number of 25 packet data communication channels in a given cell is completely independent of the actual packet data traffic load at a given time in a particular cell which means that one or more channels are reserved or occupied for carrying packet data also when there in fact is no packet data traffic at all or only to a very limited 30 extent.

Dynamic allocation as such of channels is known from a number of documents for different purposes, such as using the radio resources to the best possible extent and to obtain maximum system capacity at the same time as the power transmitted from mobile stations is minimized. For example in US-A-5 491 837 a system is shown in which measurements are performed on the mobile stations in order to determine the quality on the link and channels are allocated in dependence of the carrier to interference (C/I)-ratio. However, the disclosure of this document does not take into account any implementation of packet data communication in the system.

#### SUMMARY OF THE INVENTION

What is needed is therefore a cellular radio communication system supporting communication of packet data in which the available channel resources in each, or at least a number of cells, are used to a high or satisfactory extent irrespectively of whether the packet data traffic is low or high, regular or irregular. A system is also needed which enables a satisfactory frequency planning enabling an efficient use of channel resources. A system is also needed which provides a good grade of service as far as packet data communication is concerned.

A method of allocating/deallocating channel resources in a cellular radio communication system supporting communication of packet data through which the above-mentioned advantages are obtained is also needed.

Therefore a cellular radio communication system is provided which comprises a number of base stations each of which serves a cell, a number of switching arrangements, each of which in turn serving a

number of base stations and a number of mobile stations. Traffic channels are used for carrying speech and/or circuit switched data and control channels are provided for carrying signalling information or synchronization information. The communication  
5 system furthermore supports communication of packet data. The system comprises a number of resource management nodes for managing channel resources, e.g. allocating/deallocating channel resources, and in addition thereto a number of packet data  
10 handling nodes are provided for handling the packet data services in the system. At least in some of the cells, channel resources are allocated for communication of packet data in dependence of the demand to send packet data in the respective cells.

The resource management nodes as well as the packet data handling  
15 nodes can be arranged in a number of different ways in the system. For example, according to one embodiment, the resource management nodes are associated with the switching arrangements which for example are so called mobile switching centers (MSCs). In an  
20 alternative embodiment, however, the resource management nodes are arranged separately from the switching arrangements throughout the system. Of course any combination thereof is possible, meaning that some resource management nodes may be arranged separately  
25 from the switching arrangements whereas other resource management nodes are associated with switching arrangements. Further still the packet data handling nodes may be associated with the  
switching arrangements or they may be arranged separately from the switching arrangements. Still further some of the packet data  
30 handling nodes may be associated with switching arrangements whereas others are not. Yet further the packet data handling nodes may be arranged separately from the resource management nodes or they may be associated with them. In principle any combination is

possible. In general each cell comprises a broadcast channel for broadcasting information about the channel structure of all channels in the respective cell. A mobile station entering a cell or starting up a packet data session in a cell is via the  
5 broadcasting channel informed about whether the cell supports packet data communication or not. According to the invention, a mobile station entering a cell, or starting a packet data session in a cell which has no channel allocated for packet data communication, issues a request to the management node responsible  
10 for the cell, for a packet data channel resource. If there is an available traffic channel, such is reallocated as a packet data communication channel. Particularly the mobile station includes means for sending a message requesting a resource for packet data transmission on a signalling control channel to the relevant  
15 resource management node. The message may for example be contained in a set-up message and the resource management node receiving the request includes means for ordering the base station serving the cell to search for an available traffic channel. If an available traffic channel is found, the base station blocks the channel for  
20 traffic communication i.e. speech or circuit data communication and dedicates it temporarily for packet data communication.

Particularly the (a) signalling control channel of the cell is used by the resource management node for sending an information  
25 message to the mobile station containing the information that a channel has been allocated for packet data communication. The mobile station having received such information, transmits a request for registration with the packet data handling node of the packet data communication channel and the mobile station then uses  
30 the reallocated channel for sending/receiving packet data. The resource management node also includes means for sending a message

to the mobile station over the signalling control channel if no available traffic channel is found. The mobile station then terminates the packet data session.

- 5 In a preferred embodiment, a channel allocated for packet data communication depending on demand, or in other words a reallocated traffic channel, is deallocated for carrying traffic (e.g. speech) after a predetermined period of time of non-usage of the channel for transmission of packet data by/to any mobile station in the  
10 cell. Further still, a channel allocated as a packet data communication channel depending on demand, is deallocated to function as a traffic channel if a priority call request (i.e. a priority speech/circuit data call request) is received in the resource management node.

- 15 In a preferred embodiment means are provided for establishing the amount of packet data communication in a number of cells and demand-controlled allocation of traffic channels as packet data communication channels is implemented if the amount of packet data  
20 communication exceeds a given value. In an exemplary implementation of the invention, in cells in which the packet data communication load is high, one or more channels are constantly allocated as packet data communication channels whereas in cells in which a predetermined value for the amount of packet data  
25 communication is not exceeded, demand controlled allocation of channels for packet data communication is implemented. Of course, in a cell one or a number of channel resources may be constantly allocated for packet data communication whereas additional channels may be allocated on demand if the load is so high that  
30 the channels constantly reserved for packet data communications are overloaded. In a particular embodiment means are also provided

for keeping control of the time during which a channel resource, reallocated for packet data communication on demand, is used to a given extent. If it is used more or less constantly for at least a given a period of time, the channel may be allocated as a constant  
5 packet data communication channel.

Therefore a method of controlling the allocation of channel resources in a cellular radio communication system is also provided. The coverage area of the radio communication system is  
10 divided into a number of cells and it supports packet data communication. Traffic channels are used for carrying speech and/or circuit switched data in a conventional manner as well as control channels are used for signalling and/or synchronization information. According to the method, at least in some of the  
15 cells, channels used for carrying traffic/circuit switched data are reallocated for communicating packet data in dependence of the demand in the respective cell. The method preferably includes the steps of: broadcasting information from a resource management node to all mobile stations in the cell about the actual channel  
20 structure in the cell, ordering the base station serving the cell to search for and to block a traffic channel when a packet data communication channel is requested by a mobile station entering or being in the cell, intending to start up a packet data session, i.e. sending and/or receiving packet data, requesting the base  
25 station to start up the channel for packet data communication and, providing information to the mobile station about the channel reallocated for packet data communication and performing a registration with the packet data handling node. Particularly the method also includes the step of transmitting information from the  
30 resource management node managing the cell to a mobile station requesting a packet data transmission resource if no traffic

channel is found which is available for re-allocation as a packet data communication channel. The mobile stations then terminates the packet data communication session. In an exemplary embodiment the method further includes the steps of collecting information about the time period during which the packet data communication channel has not been used, and deallocating a packet data communication channel allocated upon request or depending on demand as a traffic channel if a predetermined time period is exceeded. Particularly the method includes the step of deallocating at least a packet data communication channel allocated on request or depending on demand to communicate speech and/or circuit data, i.e. as a traffic channel, if a priority speech/circuit data call request for a traffic channel is received in the resource management node and no free traffic channel is found.

Further still, for deallocating a packet data transmission channel the method particularly includes the steps of: sending a deallocation request from the data handling node to the resource management node, sending a request to block the packet data communication channel from the resource management node to the base station, transmitting a response from the base station to the resource management node, blocking the packet data communication channel, and sending a traffic channel start-up request from the resource management node to the base station and using the deallocated channel for speech/circuit data communication on request.

It is an advantage of the invention that the channels in a network will be used in a more efficient manner than in hitherto known systems and that the channel functionality will change dynamically

depending on the traffic load situation, on the demand for packet data communication resources etc.

#### BRIEF DESCRIPTION OF THE DRAWINGS

5 The invention will in the following be further described in a non-limiting way and with the reference to the accompanying drawings in which:

10 Fig. 1 very schematically illustrates the structure of a cellular communication system in which resource management nodes and packet data nodes are associated with the switching arrangements,

15 Fig. 2 is a figure similar to that of Fig. 1 disclosing an embodiment in which the resource management nodes and packet data handling nodes are arranged in different manners,

20 Fig. 3 illustrates a mobile station moving through a number of cells,

25 Fig. 4 schematically illustrates starting-up of a packet data communication channel on demand for a mobile station entering a cell,

Fig. 5 is a figure similar to Fig. 4 in which a mobile station starts up a packet data session in a cell,

30 Fig. 6 schematically illustrates deallocation of a packet data communication channel due to non-usage for a predetermined period of time,

Fig. 7 schematically illustrates deallocation of a packet data communication channel due to reception of a priority call,

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Fig. 8 shows a flow diagram describing re-allocation of a traffic channel as a packet data communication channel on demand,

10 Fig. 9 is a simplified flow diagram describing deallocation of a packet data communication channel due to non-usage, and

15 Fig. 10 is a flow diagram illustrating deallocation of a packet data communication channel due to a priority call request.

#### DETAILED DESCRIPTION OF THE INVENTION

Fig. 1 is a very schematical illustration of a cellular communication system. With each cell a base station is associated, here base stations BS1, BS2,... serving the particular cell in which it is arranged. A number of switching arrangements, here particularly illustrated as mobile switching centers M-RD1, M-RD2, are provided, each of which serves a number of base stations. Each MSC is connected via wire links to the base stations it serves, for example M-RD1 is responsible for base stations BS3, BS4, BS9, BS10, BS11, BS17, BS18 whereas M-RD2 controls base stations BS6, BS7, BS12, BS13, BS14, BS20, BS21 etc. For reasons of simplicity only two switching arrangements are illustrated in the figure. It should be obvious to anyone skilled in the art that the particular cell structure, the number of cells and the number of base

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stations controlled by one switching arrangement can differ a lot and the invention is not limited to any particular structure or similar.

5 A number of resource management nodes are provided for handling the allocation/deallocation of radio resources in the network. In the example as illustrated in Fig. 1 the resource management nodes and the data handling nodes are associated with the respective switching arrangements M-RD1, M-RD2.

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In Fig. 2 a cellular communication system similar to that of Fig. 1 is schematically illustrated. In this embodiment, however, the switching arrangements, here called MSC1 and MSC2 since they have the functionality of ordinary switching arrangements, respectively  
15 are arranged in cells 10 and 13 whereas additional switching arrangements MSC3, MSC4 and MR-1 are arranged in cells 37, 40 and 63 respectively. However, in this embodiment a resource management node RRMN-1 is separately located in cell 26 and it manages the cells belonging to MSC1, MSC2 and MSC4. A data handling node PDN  
20 is provided in cell 23 and it handles the packet data service in cells controlled by MSC1, MSC2 and MSC3. In cell 63 a switching arrangement, MR-1 is provided with which a resource management node is associated which controls at least the cells belonging to MSC4. In cell 60 a combined PDN/RRMN is provided. For reasons of  
25 clarity, the base stations are indicated in some of the cells. This embodiment is illustrated to show that in one and the same network packet data nodes as well as radio resource management nodes either can be associated with switching arrangements or not and in that more than one alternative can be used in one and the  
30 same system.

In Fig. 3 cells C1', C2', ..., C7' of a cellular communication system are illustrated. In each cell C1', C2', ..., C7' a base station BS1', BS2', ..., BS7' is arranged. In the illustrated embodiment it is supposed that the switching arrangement, here a mobile switching center MSC is associated with the resource management node RRMN and the packet data node PDN, i.e. included in one and the same entity 10. Mobile station MS1 moves around in the network for example through cells C5', C6', C7', C4'. The user of MS1 uses the packet data service and it is a requirement of the user that the packet data service is not interrupted in case the user enters a cell not supporting the packet data service, i.e. a cell having no channel allocated as a physical packet channel PPCH. Here it is supposed that cells C5', C7' and C4' along the route of MS1 all have a channel allocated as a physical packet channel PPCH and it is irrelevant whether in any or more of these cells such a packet data communicating channel has been allocated on demand or whether it is constantly allocated as a packet data communicating channel. However, cell C6' does not support the packet data service, i.e. no channel is allocated for packet data communicating purposes at the time being. For example the user of MS1 starts the packet data session in cell C5', which includes a physical packet data channel. When MS1 enters cell C6', through the broadcast information sent out on the broadcasting channel (BCCH) MS1 is made aware of the fact that C6' does not contain a PPCH. MS1 then requests the network, i.e. the radio resource management node RRMN for a PPCH, i.e. MS1 requests the starting up of a PPCH by using a traffic channel TCH available for reallocation in C6'. The procedure when a mobile station is informed that there is no PPCH in a cell in which the user needs to use the packet data service will be further described with reference to Fig. 4.

Fig. 4 schematically illustrates the messages and the information sent between the mobile station MS, the base station BS, the packet data node PDN and the radio resource management node RRMN in a system according to the invention in which at least a particular cell uses allocation of packet data communication channels, also called packet physical channel PPCH, on demand.

When for example a mobile station MS detects that it needs to perform a channel re-selection for example due to poor radio coverage on the currently used packet physical channel PPCH, the MS starts listening to the broadcasting channels BCCH of the neighbouring cells. The MS selects the strongest BCCH. Of course the MS may also select some other BCCH, if there are some particular reasons therefore; this is irrelevant for the functioning of the present inventive concept. The broadcast information is sent out over the broadcast channels of the respective cells by the resource management node RRMN.

When the MS has selected a BCCH (i.e. a cell) and received the information broadcasted over said BCCH, it is supposed that MS detects that the particular cell does not have any channel allocated as a PPCH. The MS then sends a message to the network, i.e. to the resource management node RRMN, for a PPCH, requesting that a PPCH is started up in the cell. Advantageously this message is sent on the signalling control channel SCCH. This can be done in different ways, for example through the use of a particular message type used in the SETUP message. Alternatively a specified feature activation code can be used in the SETUP message. The SETUP message is a message initiating a call establishment. For example for the PDC (Pacific Digital Communications) it is

described in RCRSTD-27F (Personal Digital Cellular Communication System), ARIB Standard (Association of Radio Industries and Business), issued April 30, 1991, last revised, revision F February 18, 1997. The invention of course also relates to other  
5 cellular communication systems, such as GSM (Global System for Mobile Communications) with its GPRS (General Packet Radio Service), (D)-AMPS, ADC etc. Also other alternatives are possible, the essential being that a message is sent requesting the starting up of a PPCH. When such a request or message is received in the  
10 RRMN, the RRMN searches for a traffic channel TCH that is available for re-allocation in the cell. If the RRMN finds such an available TCH, that TCH is marked busy and RRMN sends a blocking request to the base station BS of the cell, i.e. the BS is requested to block the found TCH. When the BS has blocked the  
15 particular TCH, it sends a response to the RRMN informing RRMN that the particular TCH is blocked.

The RRMN then sends a request to the BS to start up a PPCH using the same resource that was blocked for communication of  
20 speech/circuit data, i.e. to reallocate the channel used as a traffic channel to act as a PPCH instead. The BS then reports to the RRMN that the PPCH has been started up in a start-up PPCH response message. The RRMN then transmits a message to the mobile station over the signalling control channel SCCH to inform the MS  
25 that the PPCH is started and that it operates on a particular channel having a particular channel structure, i.e. the MS is informed about the channel identity and of the channel structure. The RRMN, advantageously substantially simultaneously, changes the broadcast information to include also information about the  
30 existence of the newly started PPCH so that any other mobile station entering, or intending to enter the cell, is informed

about the existence of a PPCH in the cell. The MS then moves to the PPCH and uses the PPCH for performing the normal packet channel registration procedure which is done with the packet data node PDN which issues a response message to the MS when the registration has been completed.

If, however, the RRMN is not able to find an available traffic channel, RRMN sends a message to the MS, e.g. through transmission of an error code, to inform the MS that no channel can be allocated as a PPCH in the particular cell. MS then terminates the packet data service and the user is informed that the communication with the network has been lost. Alternatively, instead of terminating the packet data service, the MS might instead listen to another broadcast channel of another neighbouring cell and the same procedure as described above would be repeated in that other cell.

In a preferred embodiment a PPCH allocated on demand, i.e. upon request, in a cell, may be deallocated or reallocated so as to reassume its original functionality on the occurrence of certain events or if some given requirements are met, i.e. a traffic channel reallocated as a PPCH on demand, may again be deallocated to function as a traffic channel. For example a time period may be defined on a per cell basis, which time period may be characteristic for a given cell or it may be the same for a number of cells within a given area such as for example a so called packet paging area which is the cell area covered by a PDN. Any alternative is in principle possible, the main thing being that if a predetermined time period has elapsed during which the channel allocated as a PPCH has not been used for carrying packet data, i.e. there are no MSs registered on this PPCH meaning that there

are no MSs which, although not actually sending any packet data, still are registered on the PPCH, it is deallocated. As soon as a demand arises, i.e. a MS requests a PPCH, a traffic channel, if available, is reallocated to function as a packet data communication channel instead, giving a very flexible system in which the channel resources are efficiently utilized. If for example, at a given time, the demand for PPCHs was high in a cell and more than one channels were allocated as PPCHs, and the demand decreases, the deallocation procedure may be carried out stepwise through deallocating one channel at a time even if the demand for example has gone down so drastically that there actually is no demand at all for a predetermined period of time, for example taking into account the fact that the probability that the demand goes up again in short may be high or for some other reason. Alternatively, the deallocation of channels may of course be coordinated so that if there is actually no demand at all for PPCHs, all PPCHs of the cell may be deallocated substantially simultaneously.

Another reason for deallocating a PPCH may be the reception of a priority speech/circuit data call requiring a traffic channel. One example on a priority speech/circuit data call is an SOS-call from another mobile station in the cell and if there are no free traffic channels available. According to different embodiments both or either reasons for deallocation of a PPCH may be implemented in one or more cells of the system. It is also possible to constantly allocate a PPCH allocated on demand as a "constant" PPCH if the demand exceeds a given value or if it is high during a predetermined time interval which advantageously is quite long.

The embodiment described with reference to Fig. 4 assumes that the MS has done a first packet registration in a cell containing a PPCH. In Fig. 5 the case is illustrated when a MS wants to initiate a packet data session when it is in a cell having no PPCH. With reference to Fig. 3 it is e.g. supposed that MS1 wants to start up a packet data session when it is in C6'. The procedure is substantially the same as the procedure described with reference to Fig. 4, but instead of a packet channel registration request a packet communication registration request is sent from the MS to the PDN when a PPCH has been started up. The signal from PDN to the MS will then, correspondingly, be a packet communication registration response.

Fig. 6 schematically illustrates the sending of messages in the case of deallocation of a PPCH because of non-usage during a predetermined time interval.

In a preferred embodiment the detection of non-usage of an on-demand allocated PPCH for a predetermined time takes place in the packet data node PDN. The PDN then marks the PPCH as unavailable and transmits a message to the resource management node RRMN containing a request to deallocate the PPCH. RRMN then sends a blocking request to the BS to block the PPCH. The BS sends a response message that the blocking of the PPCH has been completed to the RRMN. The RRMN then also changes the broadcast information in the concerned cell, i.e. the broadcast information will no longer indicate support for PDS in the cell or alternatively it will contain information about the level of PDS support in the cell. This is not explicitly indicated in the figure. The RRMN then sends a request to the base station to start up the channel for carrying speech/circuit data i.e. to act as a TCH again. A

response is transmitted from the BS to the RRMN. The channel resource again allocated for traffic communication will then be used by the RRMN when needed.

5 Fig. 7 schematically discloses the sending of messages when a PPCH is deallocated because of reception of a priority speech/circuit data call, in the following in short called a priority call, in the RRMN. It is then supposed that a priority call SET-UP message is received in the RRMN. This means that the RRMN has to find a  
10 free traffic channel TCH for said priority call. If the RRMN establishes that there is no channel resource having the functionality of a traffic channel available, the RRMN checks if there is any traffic channel which has been reallocated as a packet data communication channel, RRMN sends a blocking request  
15 to the base station that the PPCH be blocked. When this has been done, the BS sends a response to the RRMN. The RRMN at the same time changes the broadcast information in the concerned cell in the corresponding manner. The RRMN then sends a start-up request to the base station that the channel resource is to be re-started  
20 to function as a traffic channel again. Thereupon a response is provided from the BS to the RRMN which uses the TCH for the priority call.

The re-allocation of a channel resource used for carrying traffic  
25 as a physical packet data channel will now be described with reference to the flow diagram of Fig. 8. An MS using PDS searches and finds a new cell  $C_N$ , 100, as discussed above. The MS then receives information on the cell structure of the new cell  $C_N$  over the broadcasting channel of  $C_N$ , 101. The mobile station examines  
30 whether there is any (available) PPCH facility in  $C_N$ , 102. If  $C_N$  actually does contain an available PPCH, MS uses that PPCH, 102A.

If on the other hand MS establishes that there is no PPCH in  $C_N$  (or not sufficient capacity for packet data communication), MS sends a request for a PPCH to RRMN, 103. RRMN then examines if any free traffic channel TCH can be found, 104. If not, in this particular case, the MS terminates its PDS session 104A. If, on the other hand, a free TCH is found by RRMN, RRMN sends a request to base station BS in  $C_N$  to block the found channel resource for traffic (i.e. speech or circuit data) communication, 105. It is supposed that the found channel resource is denoted  $TCH_1$ . The base station then informs RRMN that  $TCH_1$  has been blocked, 106, for speech/circuit data communication whereupon RRMN sends an order to the base station to start-up the channel resource for packet data communication as  $PPCH_d$  (physical packet channel on demand) using the channel resource previously used for traffic communication, i.e. former  $TCH_1$ , 107. The start-up of the  $PPCH_d$  is then confirmed by the base station through the sending of a response message to the RRMN, 108, and RRMN sends information to the MS about  $PPCH_d$  and it also up-dates the broadcast information to include information about the existence of  $PPCH_d$ , 109. The mobile station then requests  $PPCH_d$  registration with the packet data node using the  $PPCH_d$  in a conventional manner, 110. The  $PPCH_d$  request is then confirmed by the packet data node by a packet channel registration response on the  $PPCH_d$ , 111.

Fig. 9 is a schematical flow diagram describing the deallocation of a channel resource from having the functionality of carrying packet data to speech/circuit data communication. It is here supposed that a time period of non-usage of the on-demand-allocated  $PPCH_d$ , after which deallocation is to take place, has been given. This information is contained in storing and processing means in the packet data node PDN. Thus, in PDN the

time period of non-usage of  $PPCH_d$  is surveilled, 201, and it is examined if the time period of non-usage of  $PPCH_d$  exceeds a predetermined threshold value  $T_{tr}$ , 202. If the time period has not been exceeded, the channel resource remains allocated as  $PPCH_d$ , 202A. If, however, the time period is exceeded, a deallocation request is sent from PDN to RRMN, 203, requesting that the channel resource be no more used for packet data communication. Upon receiving such a deallocation request from PDN, RRMN sends a blocking request to BS, 204, that BS should block the channel resource allocated on demand for communication of packet data. BS then performs a blocking operation and sends a blocking confirmation message to RRMN, 205, that  $PPCH_d$  has been blocked. RRMN sends a start-up request to BS that the channel resource be used for speech/circuit data communication again as traffic channel TCH, 206. The TCH start-up is confirmed by the base station through a message sent to the RRMN, 207, and RRMN up-dates the broadcasting information correspondingly, 208. If there is a request for a traffic channel TCH, 209, TCH will be used for speech/circuit data, 209A. If on the other hand there is no actual request for the traffic channel resource, TCH remains available for traffic communication unless a new PDS-request is received in RRMN, 210. Of course, if such a request is received in RRMN and there are also other traffic channels available, or free, also another traffic channel may be selected for re-allocation as a PPCH on demand.

Fig. 10 is a schematical flow diagram describing the procedure when a priority speech/circuit data call set-up request is received in RRMN, 301. Upon reception of such a request, RRMN performs a search for a free traffic channel, 302. If a free traffic channel is found, 303, the found traffic channel is used

for the priority call, 303A. If, however, no free traffic channel is found, RRMN examines if there is any PPCH in the concerned cell, 304. If there is no PPCH in the cell, any traffic channel may be reallocated for the priority call set-up 304A using any appropriate technique. How this is done is not relevant for the functioning of the present invention. If however a PPCH is contained in the cell, RRMN requests the base station to block the PPCH<sub>d</sub> allocated on demand, 305. (If there are more than one PPCH one of them is selected according to same given criteria; generally if a particular PPCH is not actually used, or used only to a very limited extent, that PPCH is selected. Different selection criteria may be given.) After blocking has been performed, it is confirmed by the base station, 306, and the broadcast information is up-dated by RRMN, 307. RRMN then requests the base station to start-up a traffic channel using the channel resource that had been used for packet data communication, 308. The start-up of the traffic channel is confirmed by the base station, 309, in a message sent to RRMN, and the traffic channel is used for the priority call, 310. It should however be clear that the deallocation procedure, as described with reference to Figure 9 and Figure 10, does not have to be limited to channel resources allocated for packet data communication on demand but it could also be implemented on channel resources "constantly" allocated as packet physical channels. Alternatively the deallocation procedure, as far as channels constantly allocated as PPCH:s are concerned, only is implemented in the case of priority calls when neither any free traffic channel nor any on-demand allocated PPCH can be found.

It is an advantage of the invention that a flexible use of available channels is enabled and in that channel resources can be

utilized very efficiently. It is also an advantage of the invention that the functionality can be implemented in cells in a network in which the normal packet data service traffic normally is very low, but the operator of the network still wants to have a coverage of the packet data service which is substantially 100%. Through implementing the inventive concept the frequency planning will be optimized due to the fact that free traffic channels can be temporarily used for packet data communication. The invention is not limited to the illustrated embodiments but it can be varied freely within the scope of the appended claims.

## CLAIMS

1. A cellular radio communication system comprising a number of  
5 base stations (BS1',...,BS7'), each base station serving a cell  
(C1,...,C70;C1',...,C7'), a number of switching arrangements, each  
switching arrangement serving a number of base stations  
(BS1',...,BS7') and a number of mobile stations (MS1), traffic  
channels being provided for carrying speech and/or circuit  
10 switched data and control channels being provided for carrying  
signalling information and/or synchronization information, said  
system supporting communication of packet data,  
c h a r a c t e r i z e d i n  
that the system further comprises a number of resource management  
15 nodes (10;RRMN;M-RD1,M-RD2) for managing/allocating/deallocating  
channel resources and a number of packet data handling nodes  
(10;PDN) for handling packet data services and in that at least in  
some of the cells channel resources can be allocated for  
communication of packet data on demand for sending packet data in  
20 the respective cells.
2. A system according to claim 1,  
c h a r a c t e r i z e d i n  
that at least some resource management nodes (10;RRMN;M-RD1,M-RD2)  
25 are associated with switching arrangements.
3. A system according to claim 1,  
c h a r a c t e r i z e d i n  
that the resource management nodes are arranged separately from  
30 the switching arrangements throughout the system.

4. A system according to claim 1 or 2,  
c h a r a c t e r i z e d i n  
that at least some packet data handling nodes are associated with  
switching arrangements (10;M-RD1,M-RD2).

5

5. A system according to claim 4,  
c h a r a c t e r i z e d i n  
that at least some packet data handling nodes (10;PDN) are  
associated with resource management nodes (RRMN).

10

6. A system according to claim 1, 2 or 3,  
c h a r a c t e r i z e d i n  
that at least some packet data handling nodes (PDN) are separate  
from the resource management nodes (RRMN-1) and the switching  
arrangements (MSC1, MSC2, MSC3, MSC4).

15

7. A system according to any one of the preceding claims,  
c h a r a c t e r i z e d i n  
that each cell (C1',...,C7') comprises a broadcast channel (BCCH)  
broadcasting information about the channel structure of all  
channels of the respective cell and in that a mobile station (MS1)  
entering a cell via the broadcast channel is informed about  
whether the cell has any channel resource(s) allocated for packet  
data communication.

20

8. A system according to claim 7,  
c h a r a c t e r i z e d i n  
that the mobile station (MS1) entering a cell, or wanting to  
initiate a packet data session in a cell, having no channel  
allocated for packet data communication requests a resource  
management node (10; RRMN;M-RD1,M-RD2) for a packet data channel

25

30

resource (PPCH) and in that an available traffic channel is reallocated to act as a packet data communication channel (PPCH;PPCH<sub>d</sub>).

5 9. A system according to claim 8,  
c h a r a c t e r i z e d i n  
that the mobile station (MS1) comprises means for sending a message requesting a resource for packet data communication on a signalling control channel to a resource management node  
10 (10;RRMN;M-RD1,M-RD2), for example in a set-up message and in that the management node comprises means for ordering the base station (BS6') of the cell (C6') to search for an available traffic channel and in that if an available traffic channel is found, the base station blocks said channel for traffic communication and  
15 reallocates the channel for packet data communication.

10. A system according to claim 9,  
c h a r a c t e r i z e d i n  
that a signalling control channel is used by the resource  
20 management node (10;RRMN;M-RD1,M-RD2) for sending an information message to the mobile station (MS1) that a channel has been reallocated for packet data transmission and in that the mobile station transmits a request for packet data communication/registration with the channel for packet data communication over  
25 the packet data handling node (10;PDN;M-RD1,M-RD2) and in that when registration is completed in the data handling node (10;PDN), the mobile station (MS1) uses the reallocated channel for sending/receiving packet data.

30 11. A system according to claim 9,  
c h a r a c t e r i z e d i n

that if no available traffic channel is found, a message is transmitted by the resource management node to the mobile station to that effect and the mobile station terminates the packet data session.

5

12. A system according to any one of the preceding claims, characterized in that a channel allocated for packet data transmission in a cell on demand, is deallocated as a traffic channel after a predetermined period of time of non-usage of the channel for transmission of packet data by any mobile station in the cell.

13. A system according to claim 12, characterized in that a channel allocated as a packet data communication channel depending on the demand, is deallocated for carrying traffic if a priority speech/circuit data call request is received in the resource management node (10;RRMN;M-RD1,M-RD2).

14. A system according to any one of the preceding claims, characterized in that means are provided in the packet data nodes (10;PDN;M-RD1,M-RD2) for establishing the amount of packet data transmissions in a number of cells, and in that demand-controlled allocation of traffic channels for carrying packet data is implemented if the amount is below a given value.

15. A system according to any one of the preceding claims, characterized in that cells, in which the amount of packet data communication is high, comprise channels constantly allocated as packet data

communication channels (PPCH), whereas cells, in which the packet data communication is lower, use demand controlled allocation of channels for packet data communication purposes.

5 16. A system according to any one of claims 1-13,  
c h a r a c t e r i z e d i n  
that all cells implement demand controlled allocation/deallocation  
of channels for packet data communication.

10 17. A system according to claim 15,  
c h a r a c t e r i z e d i n  
that in a number of cells, at least one channel is constantly  
allocated as a channel for packet data communication (PPCH) and in  
that additional channels can be allocated for packet data  
15 communication on demand.

18. A system according to claim 14,  
c h a r a c t e r i z e d i n  
that if the demand for packet data communication channels has  
20 exceeded a predetermined value for at least a given period of  
time, a number of channel resources are constantly allocated as  
packet data communication channels (PPCH).

19. A method of allocating channel resources in a cellular radio  
25 communication system supporting packet data communication and in  
which traffic channels are used for carrying speech and/or circuit  
data and in which control channels are used for signalling and/or  
synchronization information,  
c h a r a c t e r i z e d i n  
30 that it comprises the step of, at least in some cells,

- reallocating (a) channel(s) used for carrying speech/circuit switched data to carry packet data on demand for packet data communication channel resources in said cell(s).

5 20. Method according to claim 19,  
c h a r a c t e r i z e d i n

that it further comprises the steps of:

- broadcasting information from a resource management node  
10 (10;RRMN;M-RD1,M-RD2) to all mobile stations in the cell about  
the actual channel structure in the respective cell,  
when receiving a request by a mobile station entering the  
cell/being in the cell for a packet data communication  
channel/for packet data communication,
- ordering the base station of the cell to search for a free  
15 traffic channel and block such a traffic channel, and if such is  
found and blocking successful,
- requesting the base station to start up such channel for packet  
data communicaiton,
- informing the mobile station about the channel reallocated for  
20 packet data communication,
- registering the mobile station with the packet data handling  
node.

21. Method according to claim 19 or 20,

25 c h a r a c t e r i z e d i n

that it further comprises the step of:

- transmitting information from the resource management node to a  
mobile station requesting a packet data communication resource  
if no free traffic channel is found which is available for  
30 reallocation.

22. Method according to any one of claims 19-21,  
c h a r a c t e r i z e d i n

that it further includes the steps of:

- 5 - collecting information about the time period of non-usage of a packet data channel allocated on demand,
- deallocating a packet data transmission channel allocated upon request or depending on demand to function as a traffic channel if a predetermined time period ( $T_{tr}$ ) is exceeded.

10 23. Method according to any one of claims 19-22,  
c h a r a c t e r i z e d i n

that it includes the step of:

- 15 - deallocating at least a packet data communication channel allocated upon request or depending on demand as a traffic channel if a priority speech/circuit data call request for a traffic channel is received in the resource management node and no free traffic channel is found.

24. Method according to claim 22 or 23,

20 c h a r a c t e r i z e d i n

that, for deallocating a packet data communication channel in a cell, it comprises the steps of:

- sending a deallocation request from the data handling node to the resource management node managing the cell,
- 25 - sending a request to block the channel resource allocated on demand for packet data communication, from the resource management node to the base station,
- transmitting a response from the base station to the resource management node,
- 30 - blocking the channel resource for packet data communication,

- sending a traffic channel start-up request to the base station from the resource management node,
- using the channel resource for traffic communication when requested.

5

25. A method of dynamically allocating channel resources in a radio communication system divided into a number of cells, in each of which a base station is arranged, which system supports communication of packet data,

10 c h a r a c t e r i z e d i n

that it comprises the steps of:

- when a mobile station requests a channel resource for packet data communication in a cell,
- examining if any channel resource used for traffic/circuit data is available, if yes,
- 15 - reallocating the channel resource for packet data communication (PPCH),
- using the channel resource (PPCH) for packet data communication.

20

26. A method according to claim 25,

c h a r a c t e r i z e d i n

that it further comprises the steps of:

- examining if the channel resource (PPCH) used for packet data
- 25 communication has not been used for packet data communication during a predetermined time period, if yes,
- reallocating the channel resource for speech/circuit data communication.

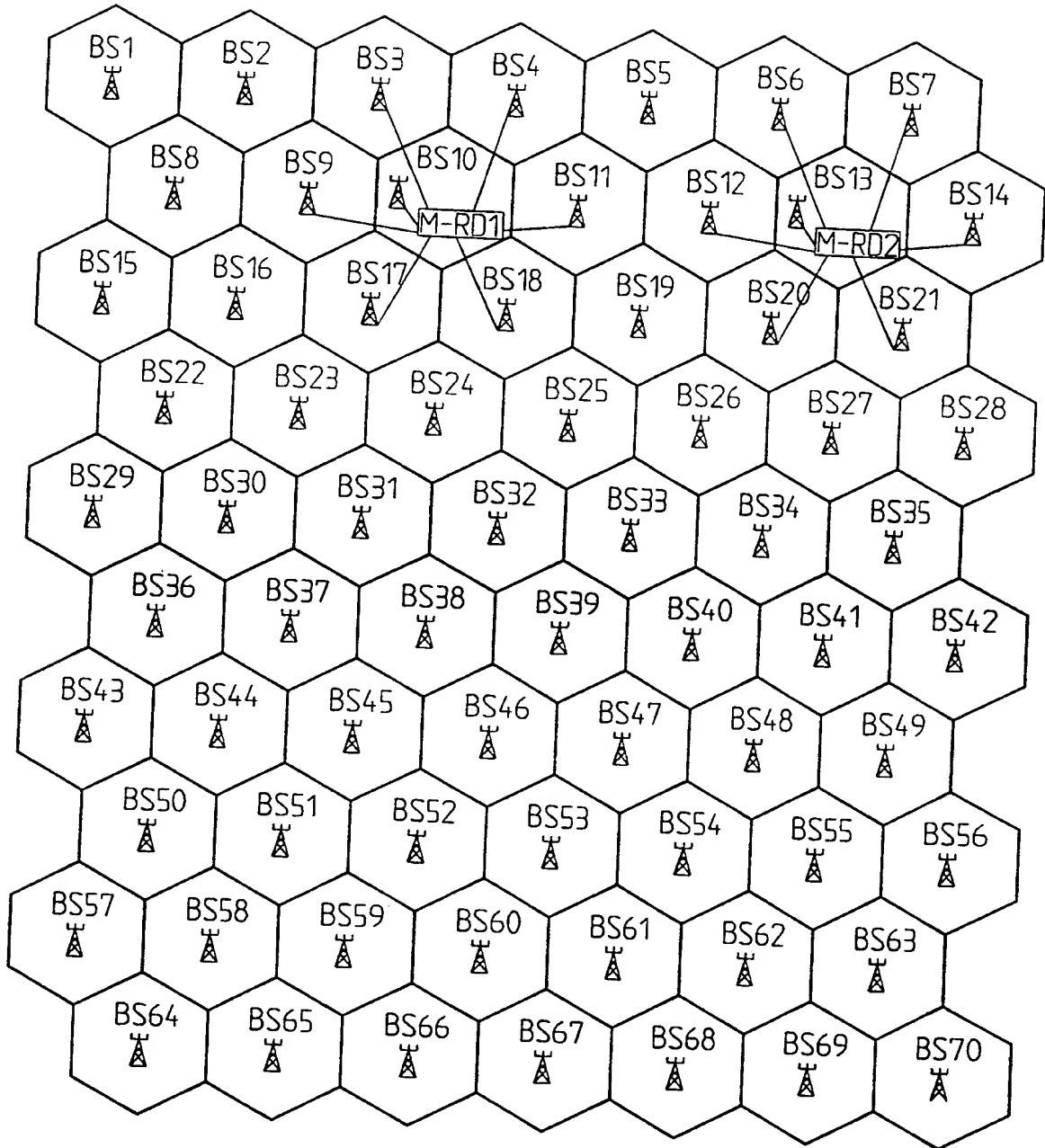
30 27. A method according to claim 25 or 26,

c h a r a c t e r i z e d i n

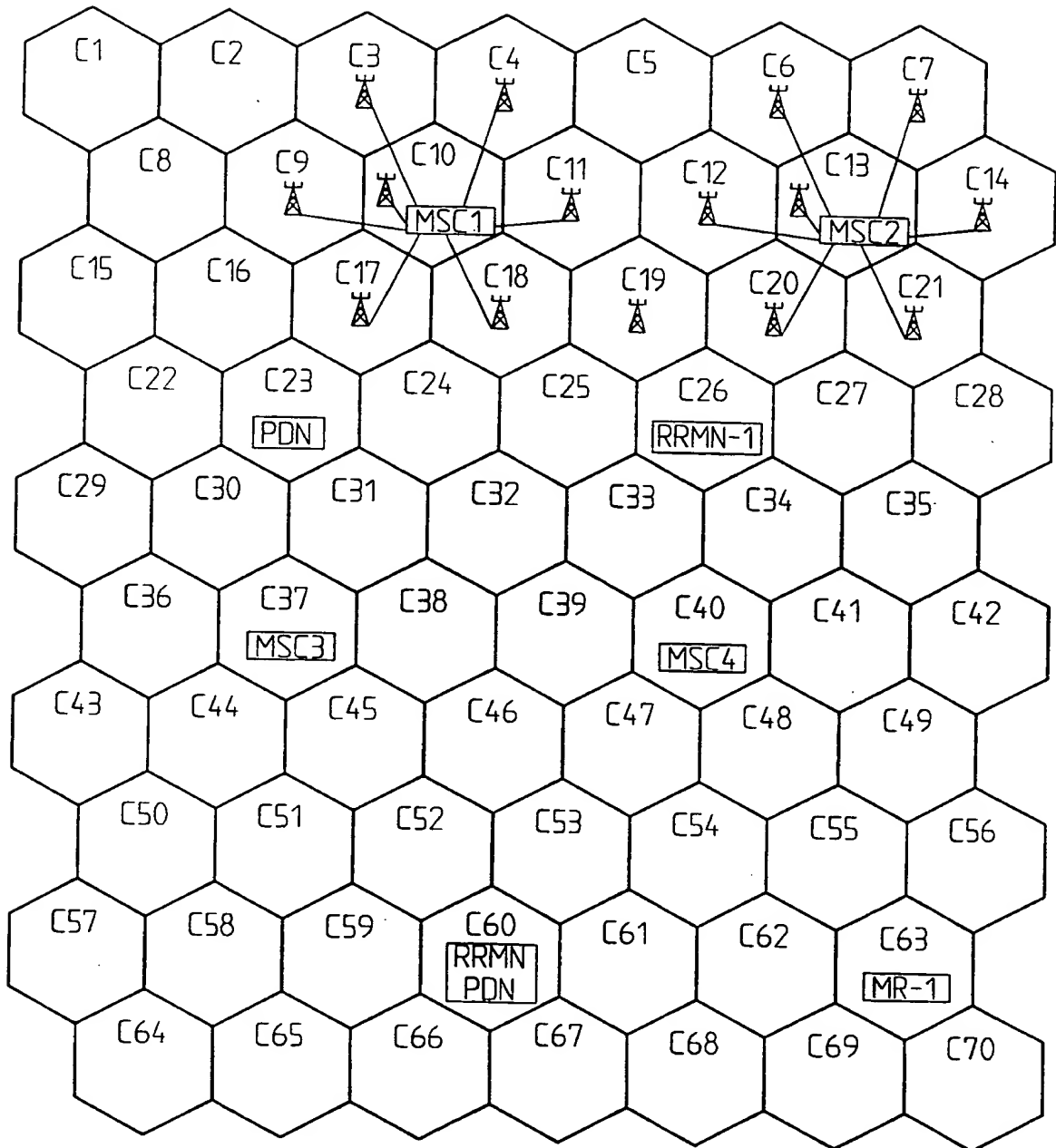
that it further comprises the steps of:

- reallocating a channel resource (PPCH) used for packet data communication to have the functionality of a traffic channel (TCH) if a priority speech/circuit data call request is received and no free traffic channel is found.

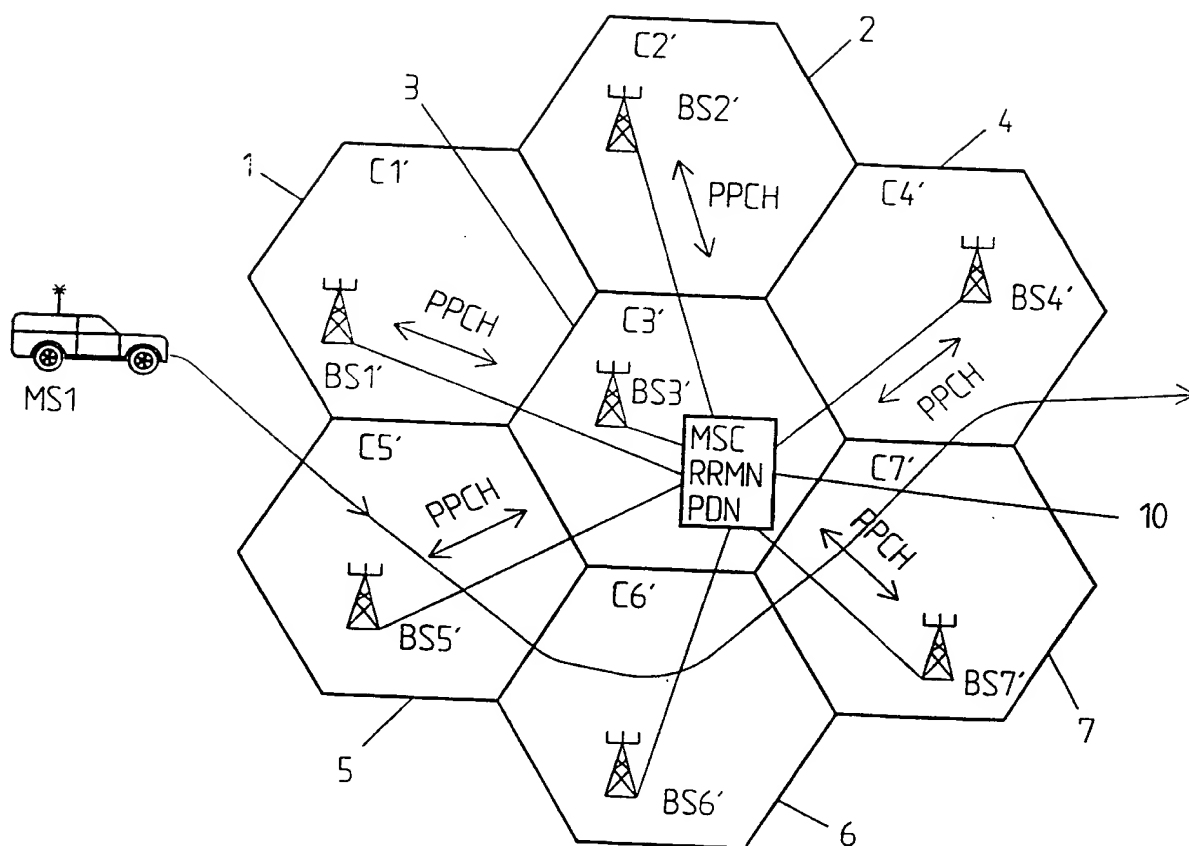
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*Fig. 1*

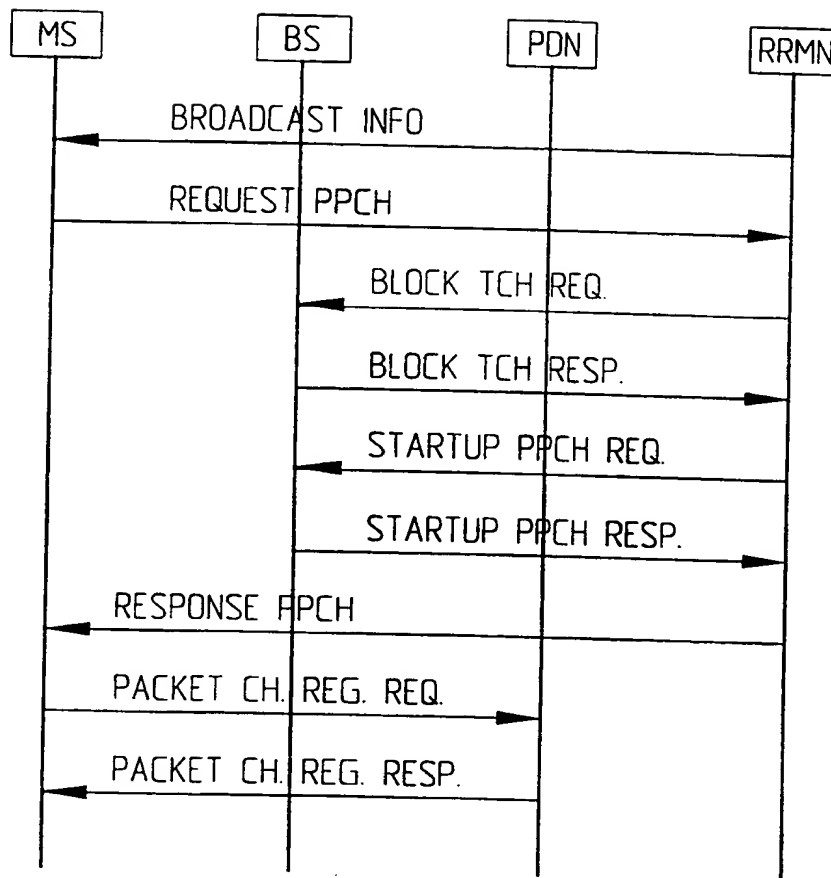
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*Fig. 2*

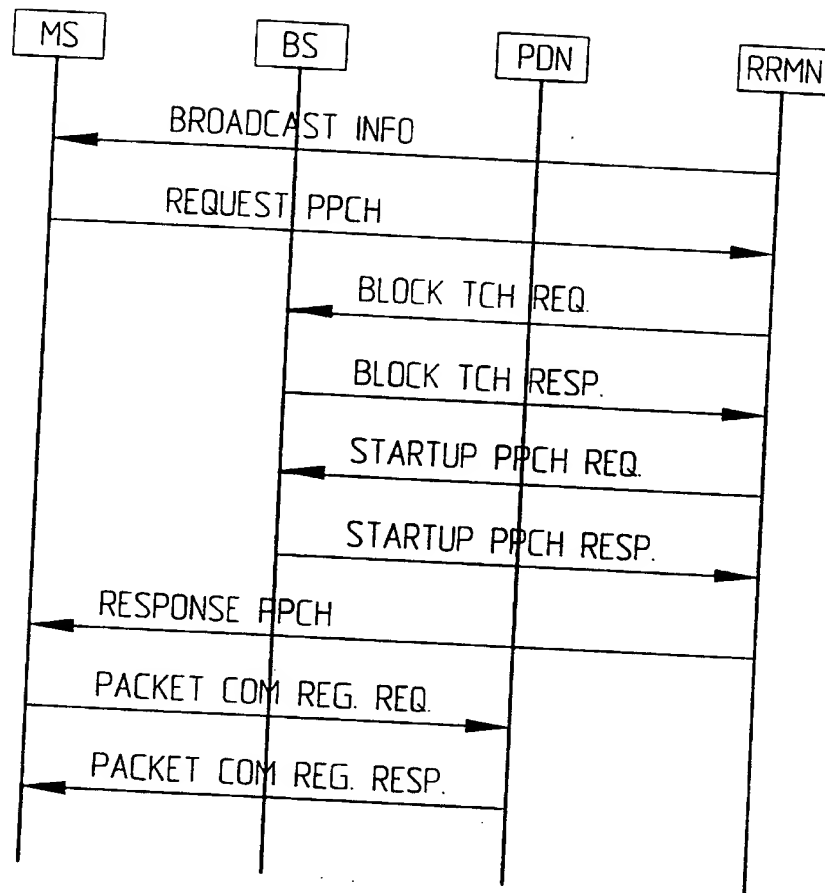
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*Fig. 3*

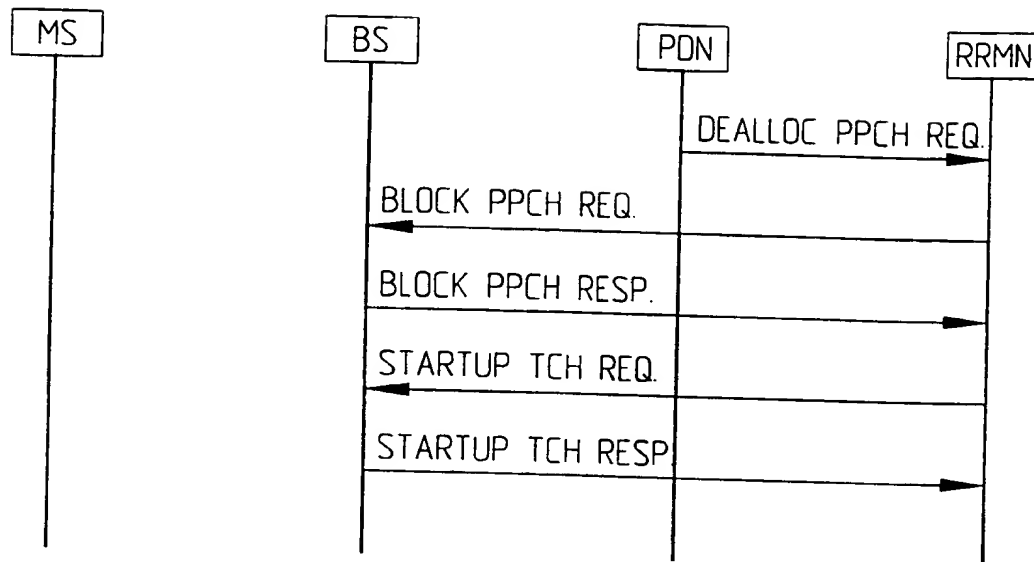
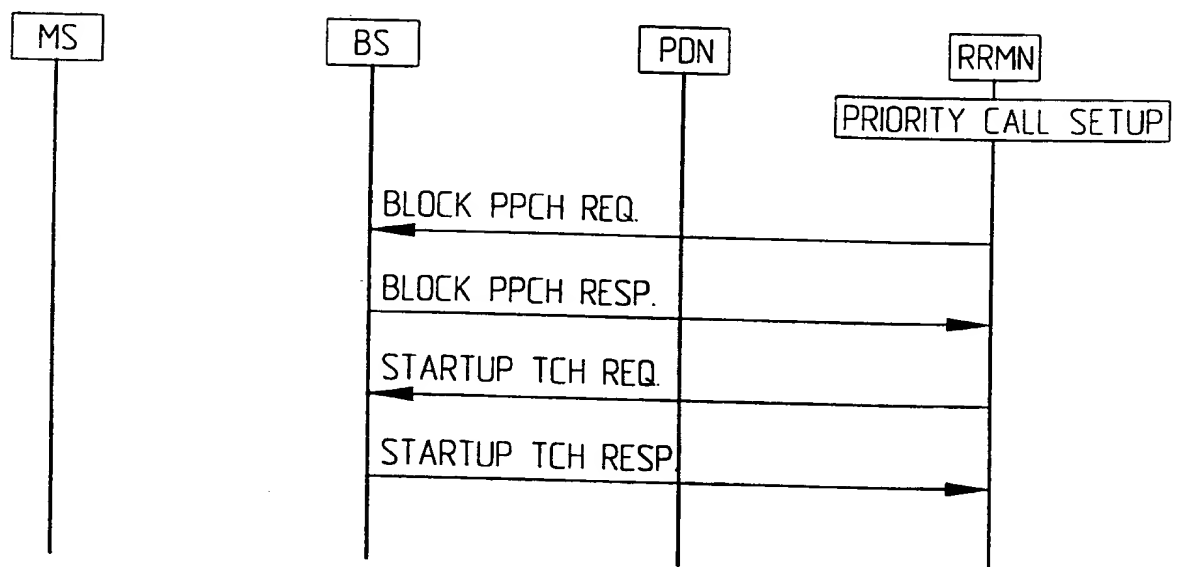
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*Fig. 4*

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*Fig. 5*

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*Fig. 6**Fig. 7*

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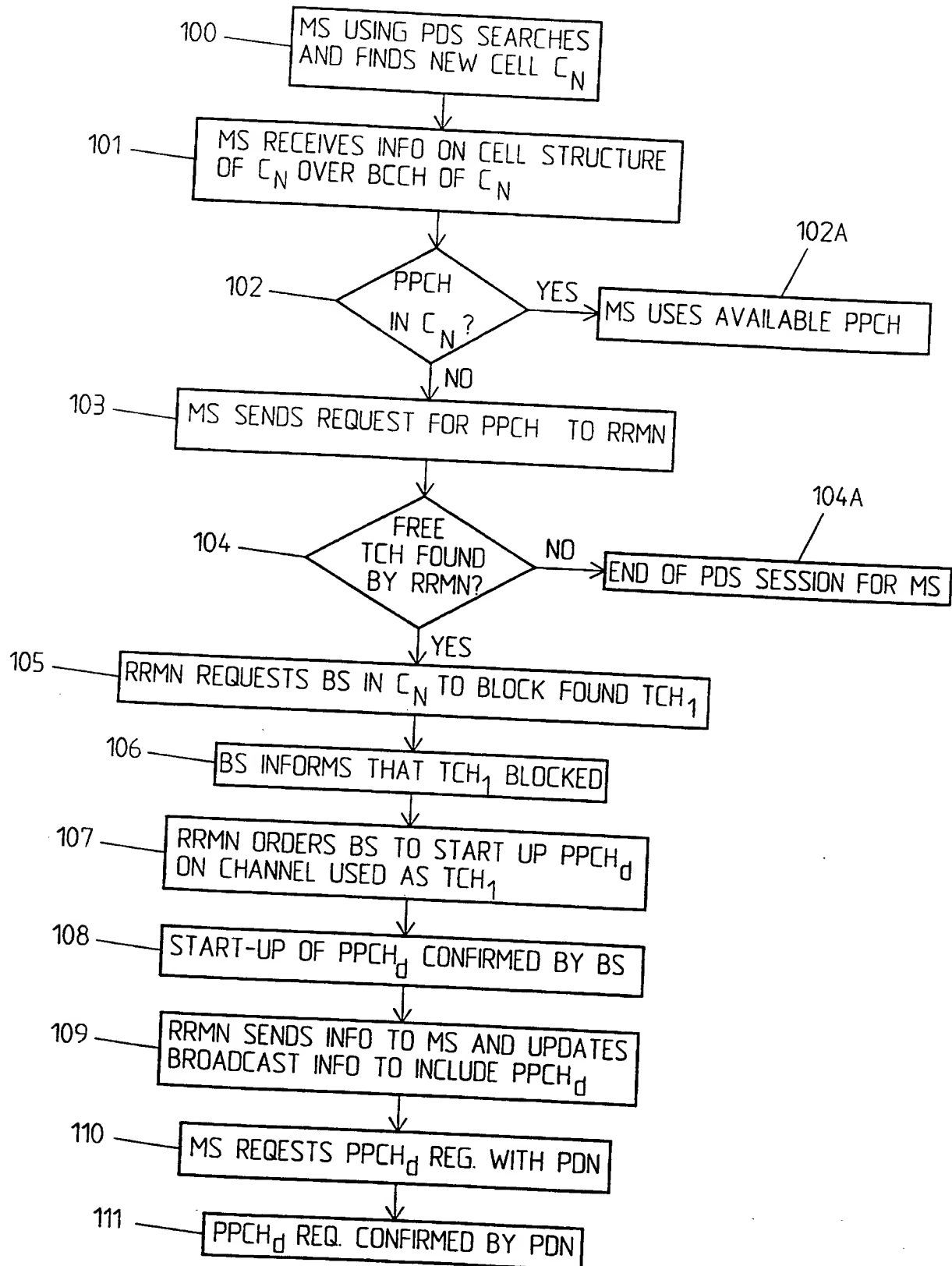


Fig. 8

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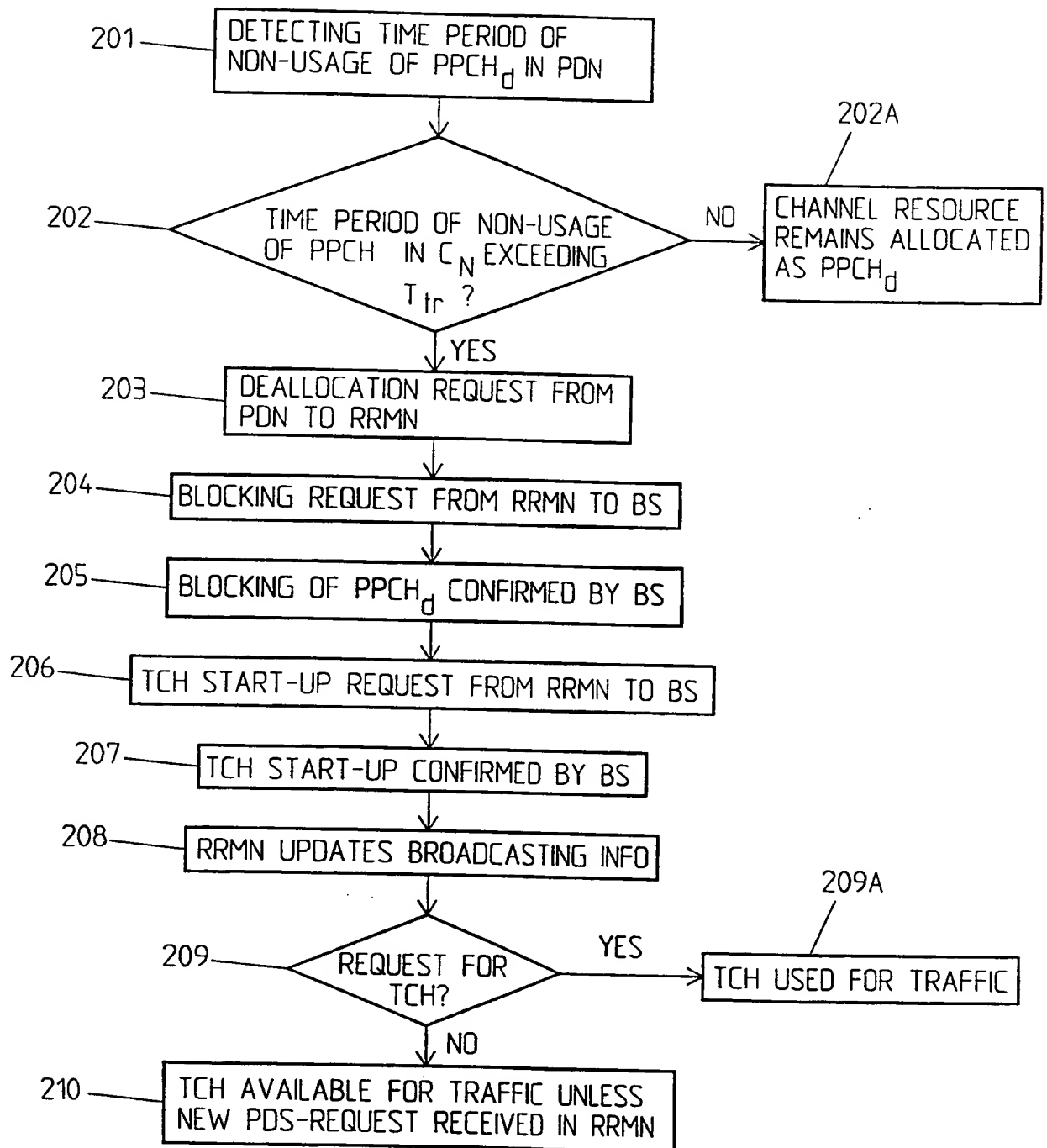
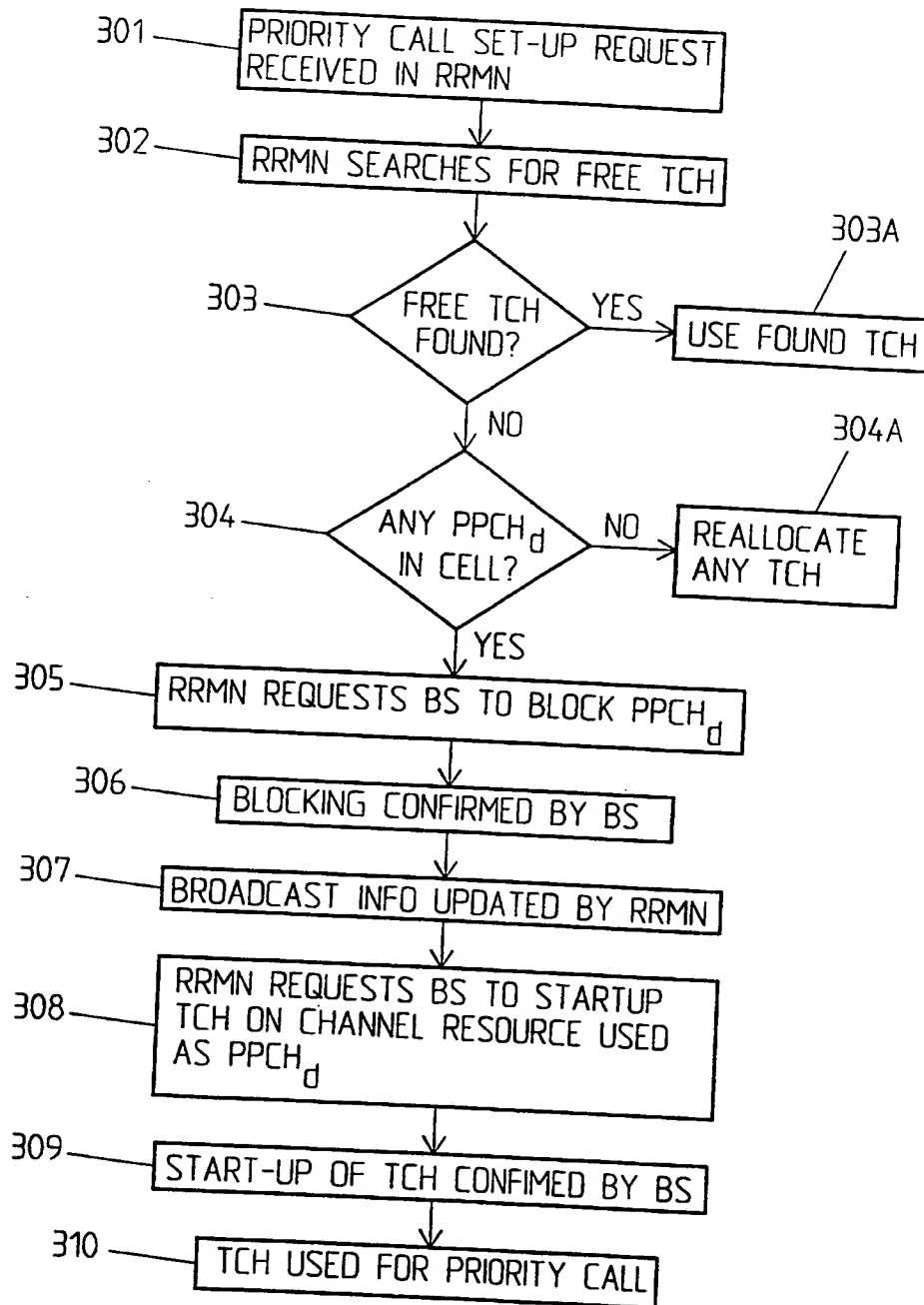
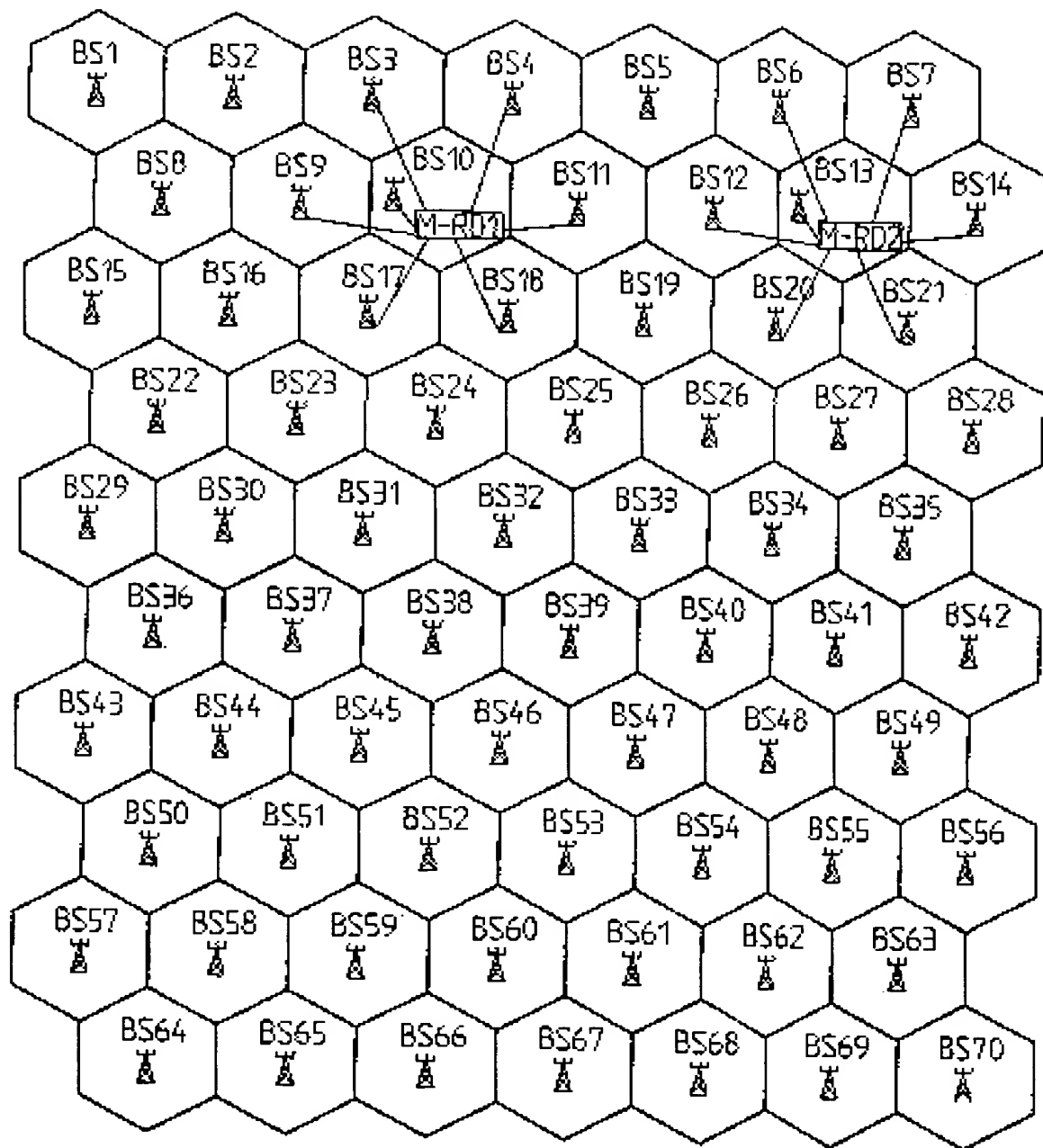


Fig. 9

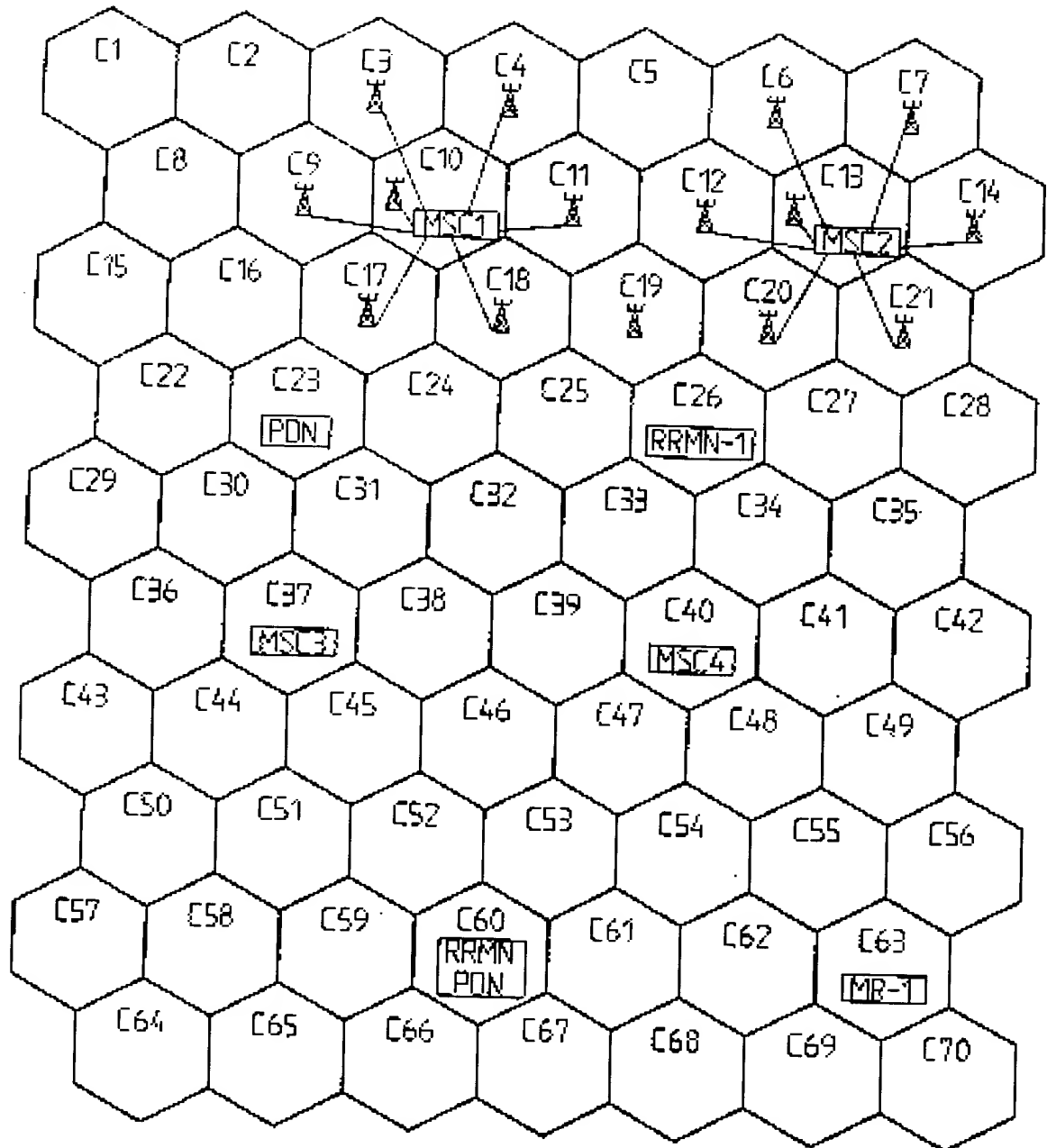
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*Fig. 10*

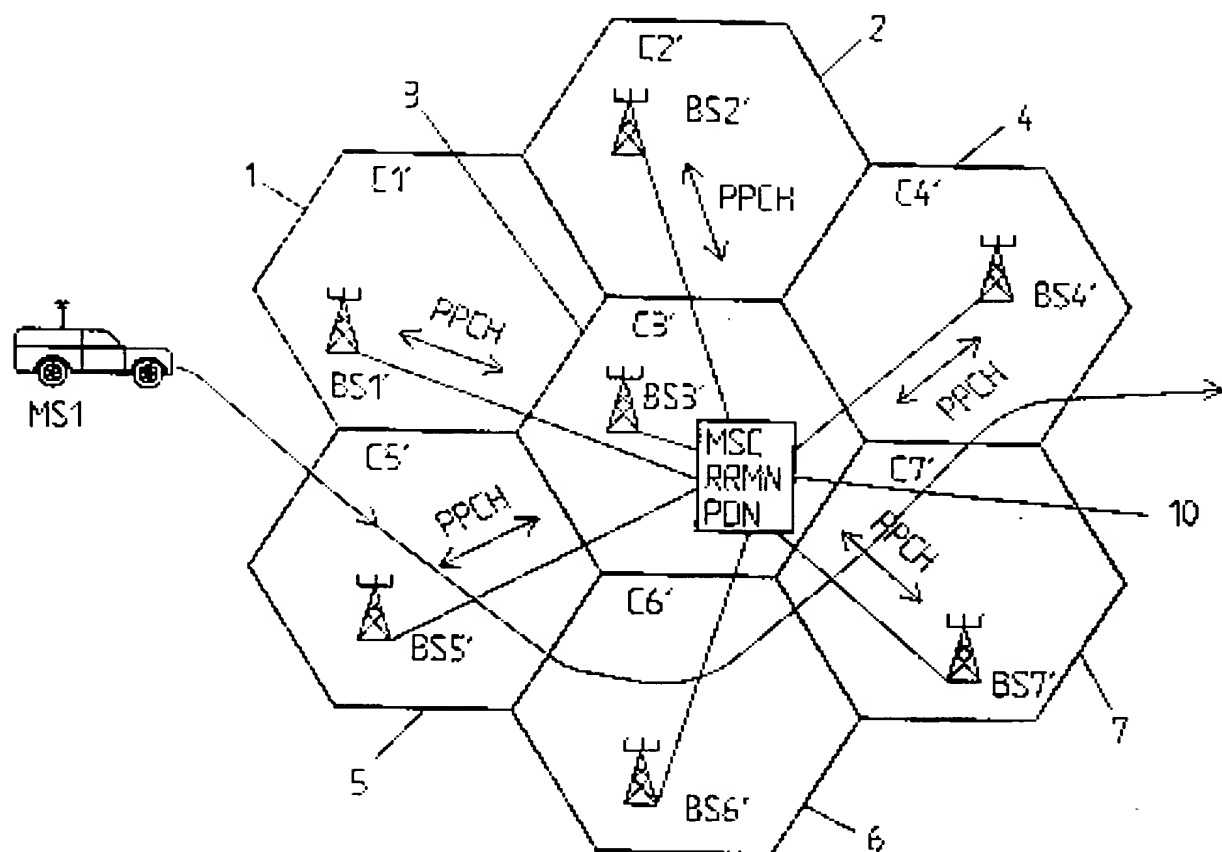
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*Fig. 1*

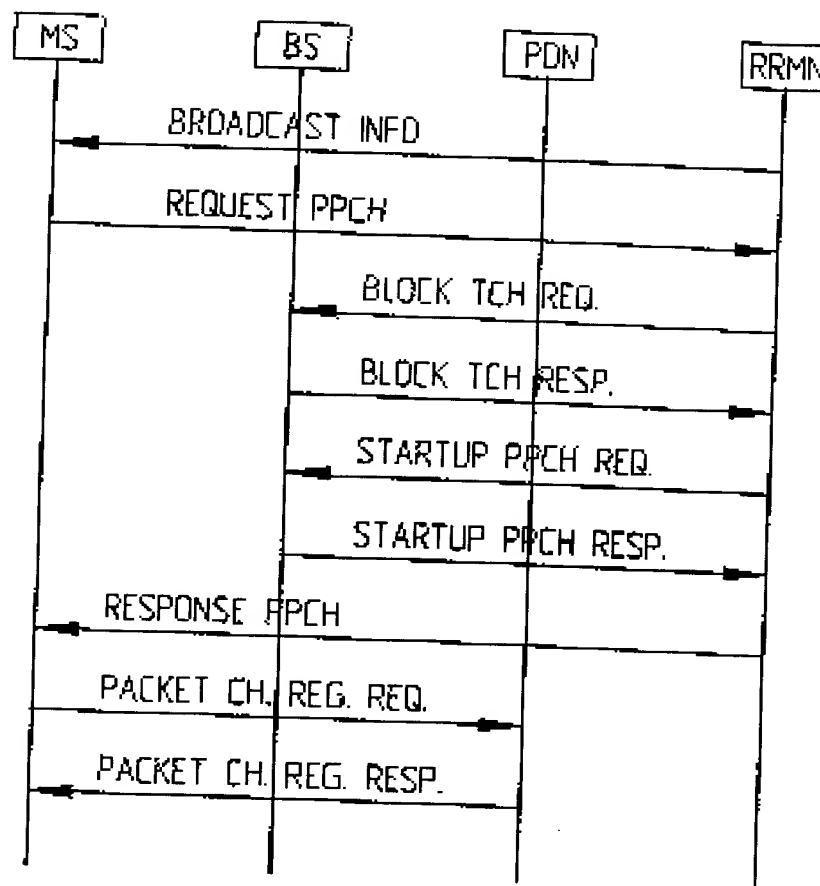
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*Fig. 2*

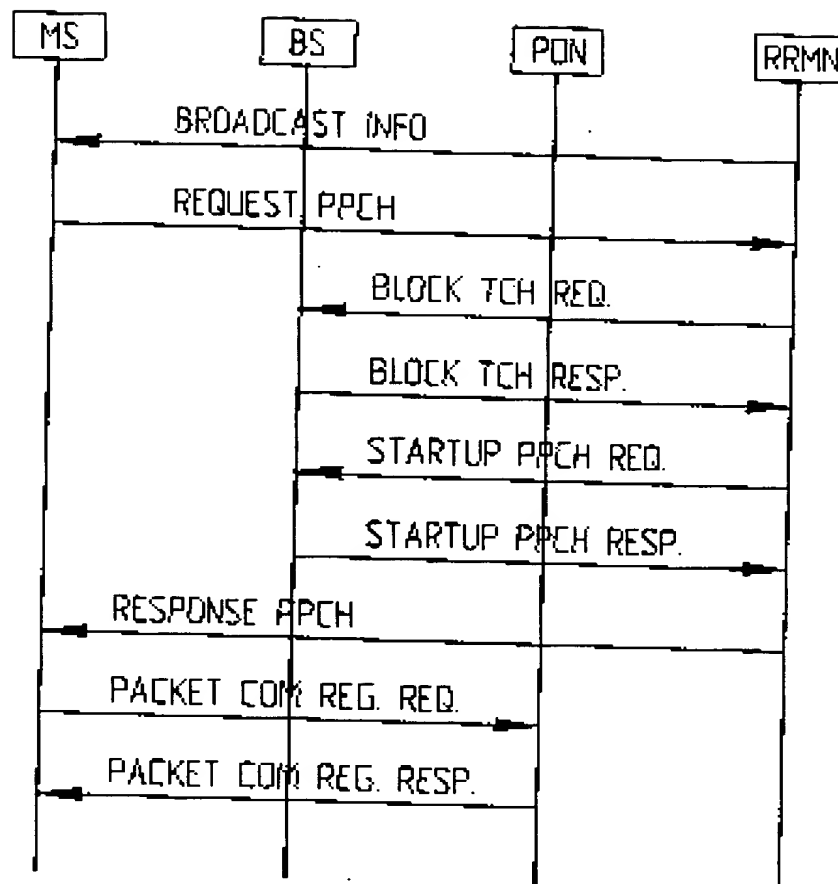
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*Fig. 3*

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*Fig. 4*

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*Fig.5*

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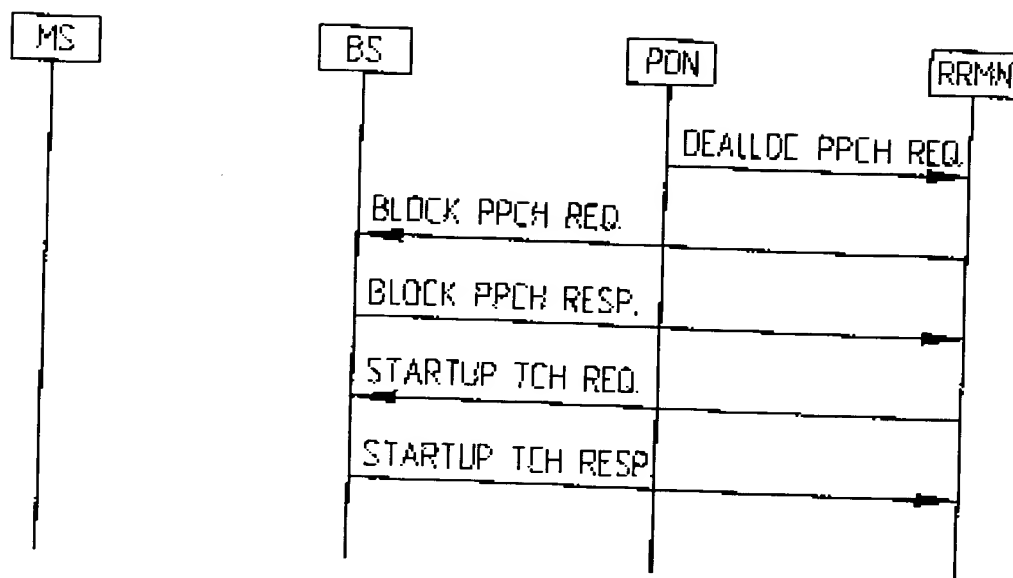


Fig. 6

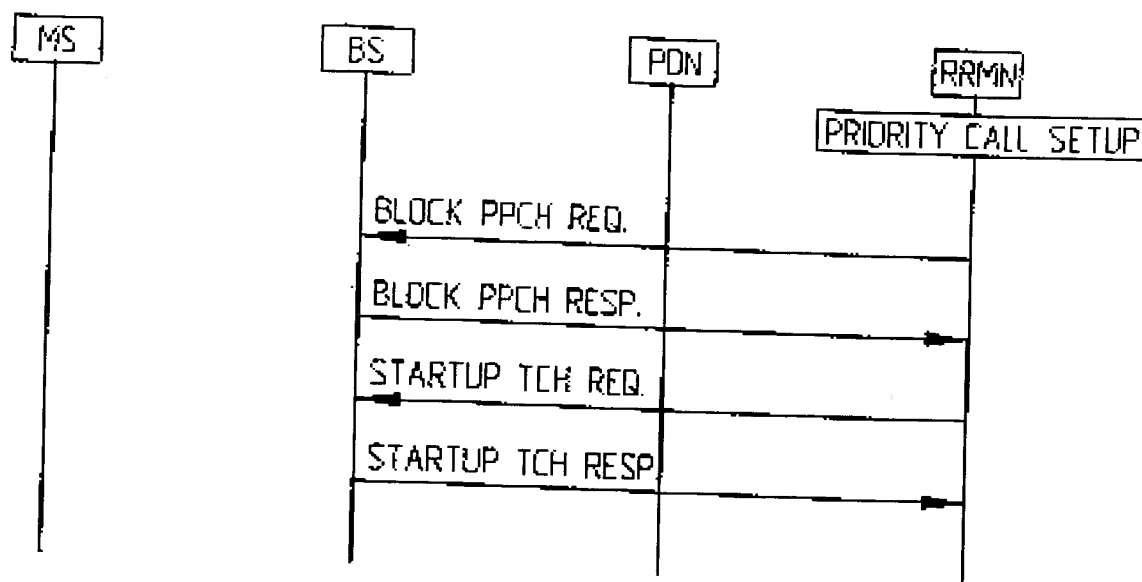


Fig. 7

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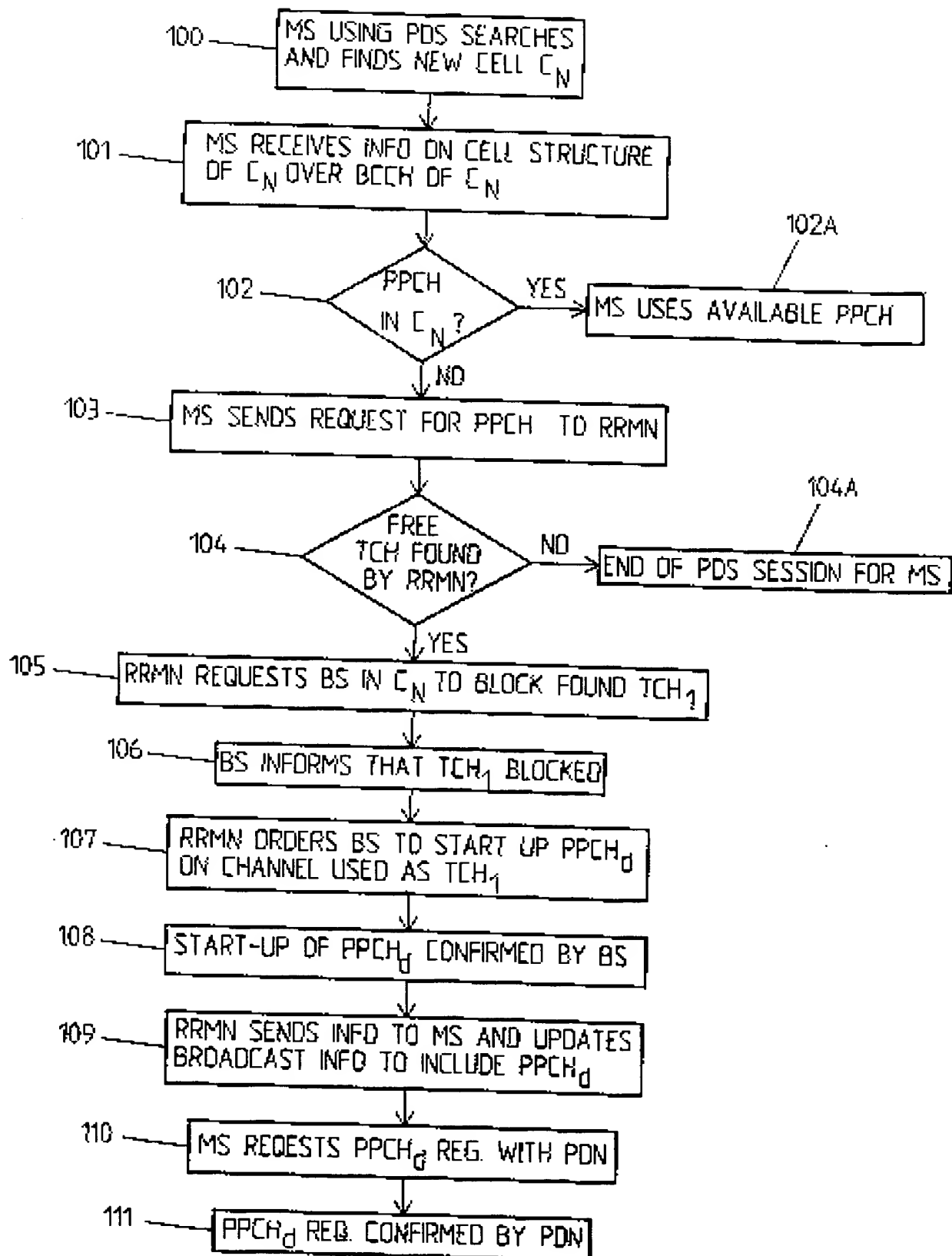


Fig. 8

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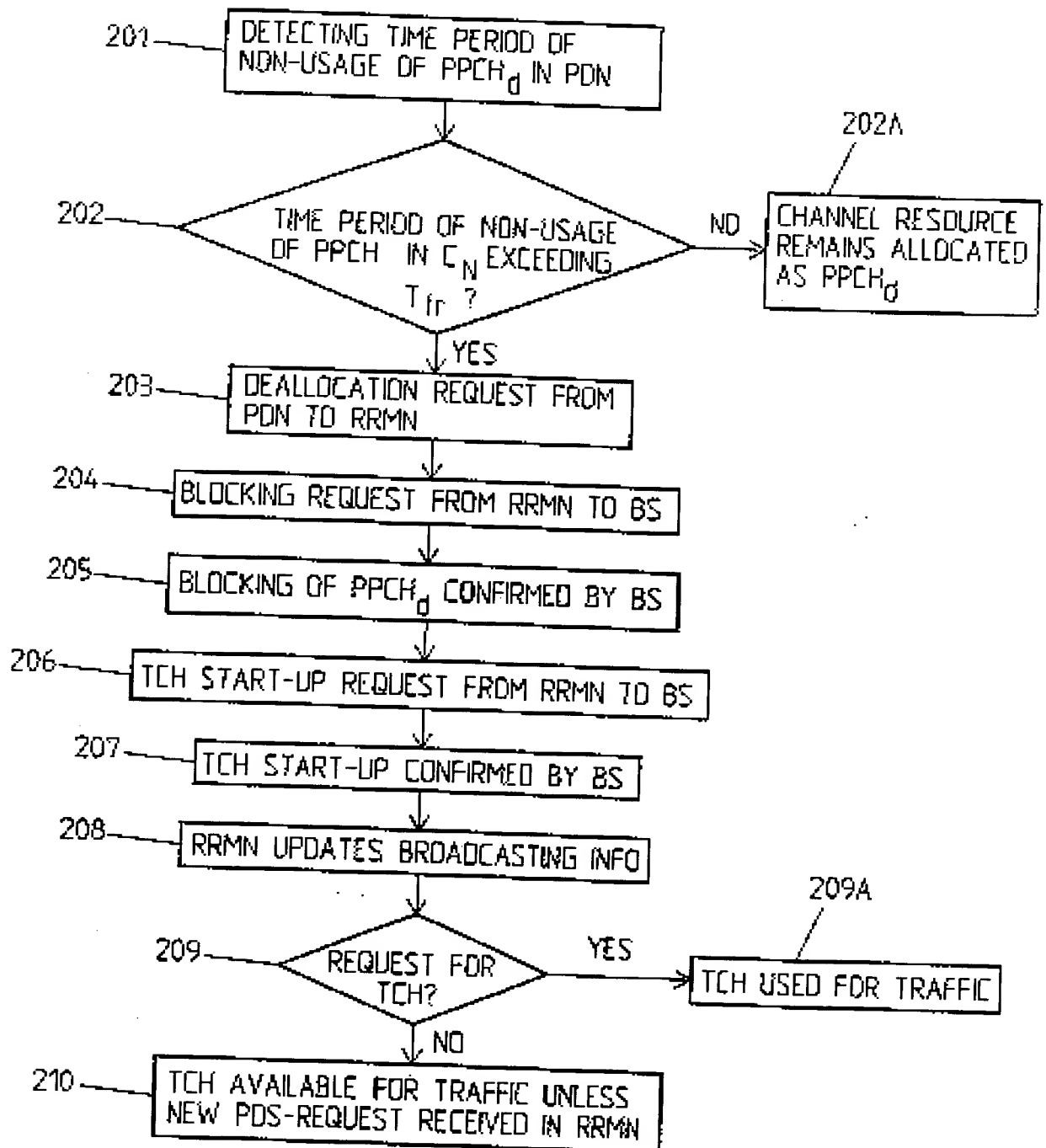


Fig. 9

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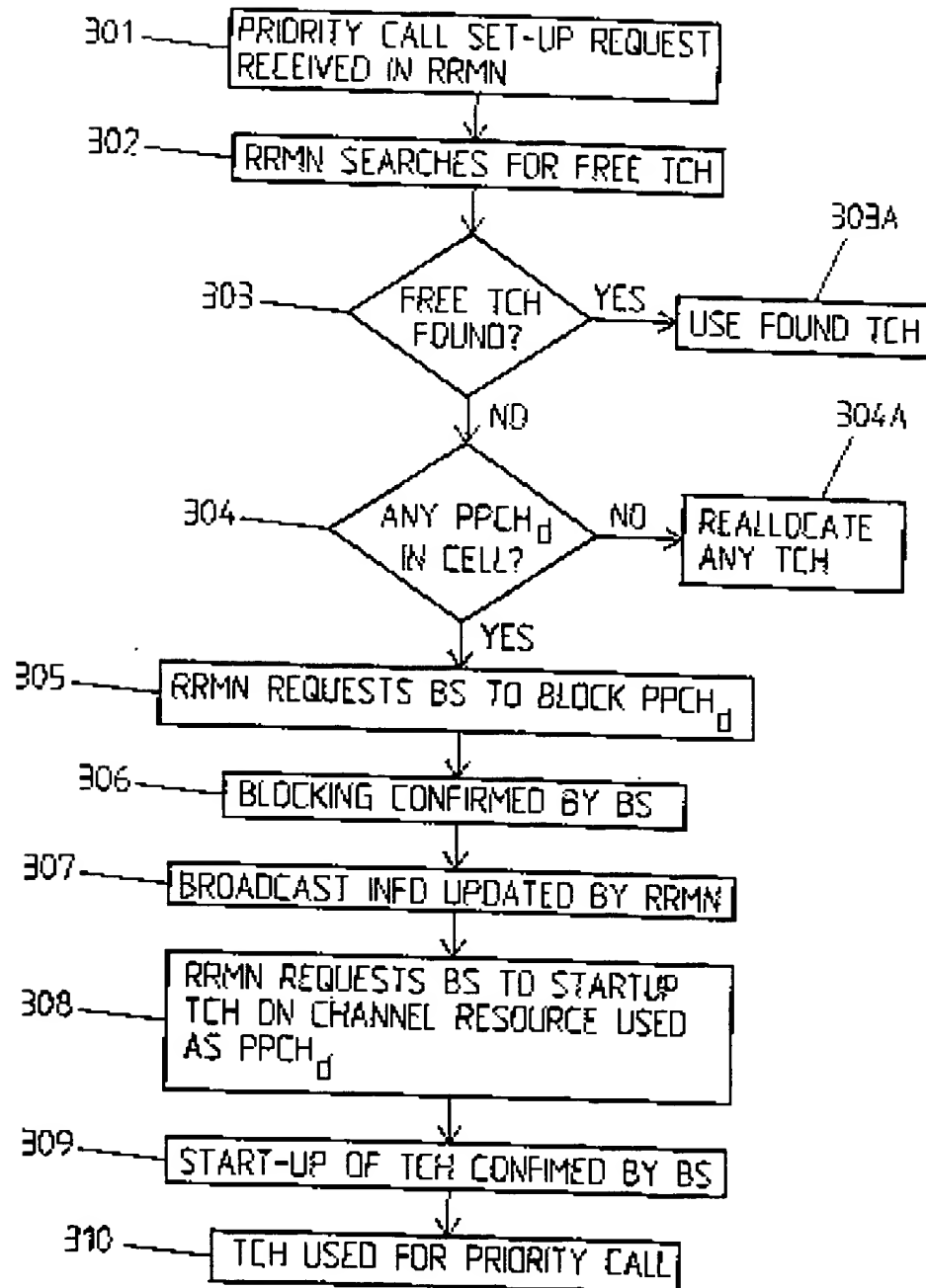


Fig. 10



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<b>(21) International Application Number:</b> PCT/SE99/00381 <b>(22) International Filing Date:</b> 12 March 1999 (12.03.99) <b>(30) Priority Data:</b> 9800868-3      17 March 1998 (17.03.98)      SE <b>(71) Applicant:</b> TELEFONAKTIEBOLAGET LM ERICSSON (publ) [SE/SE]; S-126 25 Stockholm (SE). <b>(72) Inventors:</b> HALL, Göran; Mogatan 55, S-431 64 Mölndal (SE). SUNDELL, Hans-Olof; P.O. Box 17 Kalvsund, S-430 90 Öckerö (SE). <b>(74) Agents:</b> BERGENTALL, Annika et al.; Cegumark AB, P.O. Box 53047, S-400 14 Göteborg (SE).		<b>(81) Designated States:</b> AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).  <b>Published</b> <i>With international search report.</i> <i>Before the expiration of the time limit for amending the claims</i> <i>and to be republished in the event of the receipt of amendments.</i>  <b>(88) Date of publication of the international search report:</b> 4 November 1999 (04.11.99)
<b>(54) Title:</b> ON-DEMAND CHANNEL ALLOCATION FOR PACKET DATA   <b>(57) Abstract</b> <p>The present invention relates to a cellular radio communication system comprising a number of base stations (BS1', ..., BS7'), each of which serves a cell (C1', ..., C7'), and a number of switching arrangements each serving a number of base stations, and a number of mobile stations (MS1). Traffic channels are provided for communication of speech and/or circuit switched data and control channels are provided for communication of signalling information and/or synchronisation information. The system supports communication of packet data. A number of resource management nodes (10) are provided for managing channel resources and a number of packet data handling nodes are provided for handling packet data services. At least in some of the cells resources can be allocated on demand for communication of packet data in the respective cells. The invention also relates to a method of allocating channel resources in cellular radio communication system supporting packet data communication.</p>		

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 99/00381

## A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04Q 7/36, H04L 12/56

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

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## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5594738 A (KENNETH J. CRISTLER ET AL), 14 January 1997 (14.01.97), column 3, figure 1, abstract  --	1-6,12-19, 21-27
Y	WO 9610320 A2 (NOKIA TELECOMMUNICATIONS OY), 4 April 1996 (04.04.96), page 1, line 20 - line 30; page 3, line 24 - line 26; page 5, line 15 - line 18  --	1-6,12-19, 21-27
X	WO 9610305 A2 (NOKIA TELECOMMUNICATIONS OY), 4 April 1996 (04.04.96), abstract  --	1,19,25

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"I" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&amp;" document member of the same patent family

Date of the actual completion of the international search

6 Sept 1999

Date of mailing of the international search report

15-09-1999

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 99/00381

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 9720444 A1 (AT &T WIRELESS SERVICES, INC.), 5 June 1997 (05.06.97), abstract, see summary  --	1,19,25
A	US 5121385 A (SYOJI TOMINAGA ET AL), 9 June 1992 (09.06.92), abstract  -- -----	1-27

## INTERNATIONAL SEARCH REPORT

International application No.  
**SE99/00381****Box I** Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
2. ☐ Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

**Box II** Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

**The documents found implicates a lack of inventive step in the invention claimed in claims 1, 19 and 25, and therefore lack of unity of invention a posteriori arises.**

**Claimed invention I: Arranged/Associated nodes (1-6)**

**Claimed invention II: BCCH broadcasts channel information (1, 7-11, 19-20)**

**Claimed invention III: Channel allocation on demand 13-19, 21-27)**

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
  
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

- ☐ The additional search fees were accompanied by the applicant's protest.  
☐ No protest accompanied the payment of additional search fees.

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

02/08/99

International application No.

PCT/SE 99/00381

Patent document cited in search report			Publication date	Patent family member(s)			Publication date
US	5594738	A	14/01/97	US	5515379	A	07/05/96
WO	9610320	A2	04/04/96	AU	701594	B	04/02/99
				AU	3523995	A	19/04/96
				CA	2200308	A	04/04/96
				EP	0783826	A	16/07/97
				FI	96557	B,C	29/03/96
				FI	944487	D	00/00/00
				FI	971269	A	26/03/97
				JP	10511818	T	10/11/98
WO	9610305	A2	04/04/96	AU	696802	B	17/09/98
				AU	3524095	A	19/04/96
				CA	2200307	A	04/04/96
				EP	0783811	A	16/07/97
				FI	96558	B,C	29/03/96
				FI	944488	D	00/00/00
				FI	971270	A	26/03/97
				JP	10509566	T	14/09/98
WO	9720444	A1	05/06/97	CA	2238552	A	05/06/97
				EP	0864238	A	16/09/98
				US	5790551	A	04/08/98
US	5121385	A	09/06/92	JP	2009963	C	02/02/96
				JP	2079532	A	20/03/90
				JP	7044511	B	15/05/95